

# HVAC Apprenticeship Curriculum

Revised June 2011

College of Western Idaho

*in cooperation with*

Idaho State Division of Professional Technical Education

## HVAC Year One

Total Hours: Minimum = **144**

CWI = **165**

### ▪ Basic math – Module 1

Minimum: 12 hours, CWI: 30 hours

- Whole numbers
- Addition and subtraction
- Fractions
- Decimals
- Measurement of
  - Lines
  - Area
  - Volume
  - Weights
  - Angles
  - Pressure
  - Vacuum
  - Temperature
- Trade related math

#### Objectives:

Perform addition, subtraction, multiplication, and division calculations of whole numbers  
Perform addition and subtraction calculations of common fractions  
Perform multiplication and division calculations of common fractions  
Perform addition, subtraction, multiplication, and division calculations of decimal fractions  
Perform ratio and proportion calculations  
Perform percent, percentage, and discount calculations  
Perform angular, length, and converted temperature measure calculations  
Perform area calculations  
Perform volume calculations  
Perform estimates and billing calculations

### ▪ Basic Safety Hand and Power Tools – Module 2

Minimum: 18 hours, CWI: 18 hours

- OSHA 10 hour construction training
- Tools
  - Basic hand and power tools
  - Soldering and brazing

#### Objectives:

Describe potential excavation site hazards (1hr)  
Explain proper personal protective equipment use (1hr)  
Describe proper material handling, storage, use, and disposal  
Describe ladder, stairway and scaffold hazards and proper use  
Describe jobsite electrical hazards and proper lockout/tagout use  
Describe proper refrigerant and pressure vessel usage and storage  
Identify MSDS properties for refrigerants (1hr)  
Describe proper hand and power tool use

Describes soldering and brazing methods

▪ Fuel gas piping and venting – Module 3

Minimum: 60 hours, CWI: 60 hours

- Installation of fuel piping according to code and industry standards
- Installation of venting according to code and industry standards
- Installation of combustion air according to code and industry standards
- Installation of make- up air according to code and industry standards
- IFGC requirements

Objectives:

Identify International Code administrative and enforcement rules  
Define key terms as applied to the IFGC  
Describe the building structural safety requirements for fuel gas equipment installation  
Examine fuel gas equipment combustion, ventilation and dilution air requirements  
Identify fuel gas equipment location, access and service space requirements  
Describe proper appliance condensate disposal and clearance reduction methods  
Perform gas pipe sizing exercises  
Identify proper gas pipe installation methods  
Describe proper gas pipe inspection, testing and purging procedures  
Describe chimney and vent types and construction  
Examine chimney installation requirements  
Examine gas vent installation requirements  
Describe gas appliance category I, II, III and IV characteristics  
Identify proper gas vent connector installation requirements  
Describe category I venting principals  
Perform single appliance category I vent sizing exercises  
Perform multiple appliance category I vent sizing exercises  
Determine capacity penalties for offsets in common vent and vent connectors  
Examine specific fuel gas appliance installation requirements  
Describe mechanical equipment location, access and service space requirements

▪ Introduction to code – Module 4

Minimum: 6 hours, CWI: 9 hours

How to access information related to HVAC industry

- Idaho Code and Administrative rules
- International Mechanical Code

Objectives:

Describe Idaho HVAC code and Administrative Rules requirements  
Identify International Mechanical Code general chapter requirements  
List International Mechanical Code HVAC specific equipment sections

▪ Energy sources – Module 5

Minimum: 9 hours, CWI: 9 hours

- Principles of different fuel sources
- Fuel Oil
- Electric
- Gas / LP
- Hydro / geothermal\*
- Wind / solar\*

Objectives:

Explain natural, LP gas, and fuel oil combustion characteristics  
Describe the development and application of geothermal heat pump systems  
Describe the development and application of renewable energy systems

- Basic systems overview – Module 6

Minimum: 12 hours, CWI: 12 hours

- Warm air furnaces
- Split system air conditioners
- Commercial air conditioning systems
- Forced air duct systems

Objectives:

Describe mid-efficiency and high efficiency furnace operation

Describe the typical configuration of residential split air conditioning systems

List the various types of commercial air conditioning systems and their application

Describe the configuration of four common duct systems

- Intro to applied science – Module 7

Minimum: 24 hours, CWI: 24 hours

- History of HVAC/R
- Temperature measurement and conversion
- Thermodynamics
- Pressure / vacuum
- Refrigeration cycle and components
- Basic elements of matter
- *Applied math* – 6 hours

Objectives:

Describe a brief modern history of HVAC

Describe energy types and their properties

Perform energy conversion calculations

Perform sensible, latent and total heat calculations

Differentiate between saturated, superheated, and subcooled refrigerant

Explain atmospheric, absolute, and gauge pressure relationship

Convert gauge pressure, absolute pressure and vacuum

Diagram a basic refrigeration cycle identifying pressure, temperature and state of refrigerant

List the type and function of the four major refrigeration components

- Customer Service – Module 8

Minimum: 3 hours, CWI: 3 hours

- Cleanliness
  - Site
  - Personal
- Professional appearance
- Timeliness
- Work ethic
- Communication skills

Objectives:

Describe good customer communication procedures

## **HVAC Year Two**

Total Hours: Minimum = **144**

CWI = **156**

- Appliance installation – Module 1

Minimum hours: 24, CWI hours: 24

- Oil and fuel gas appliance installation

- Split and packaged air conditioning system installation
- Forced-air system installation
- NEC – electrical code as applied to HVAC installation
- IFGC, IMC, IRC code requirements for HVAC installation

Objectives:

Explain HVAC electrical branch circuit sizing and installation factors  
 Interpret HVAC manufacturer electrical name plate data  
 Explain combustion air and venting requirements for Category I, III and IV appliances  
 Describe gas appliance installation, start-up and checkout procedures  
 Describe oil appliance installation, start-up and checkout procedures  
 Describe sheet metal, fiberglass and flex duct installation procedures  
 Identify split and packaged air conditioning unit components  
 Explain split and packaged air conditioning unit installation guidelines

■ Introduction to blueprints and specifications – Module 2

Minimum hours: 24, CWI hours: 24

- Site plans, floor plans and elevation drawings
- Mechanical, plumbing and electrical drawings
- Specifications
- Shop drawings and submittals
- Takeoff procedures
- As-built drawings

Objectives:

Read blueprints and architect plans  
 Interpret mechanical, plumbing and electrical drawings  
 Interpret specification documents and apply to plans  
 Interpret shop drawings and apply to plans and specifications  
 Describe a submittal and its derivation, routing and makeup  
 Develop cut lists for duct runs from shop drawings  
 Interpret as-built modifications on HVAC mechanical plans  
 Perform an HVAC equipment and material takeoff

■ Basic electricity – Module 3

Minimum hours: 60, CWI hours: 60

- Basic electrical theory
- Electrical safety
- Series and parallel circuits
- AC and DC theory
- HVAC electrical control devices
- HVAC electrical load devices
- HVAC electrical schematic diagrams
- Power generation and distribution
- HVAC branch circuits
- Applied math – 9 hours integrated
  - Ohm's Law
  - Engineering notation
- Single-phase, three-phase and ECM Motors
- Single-phase motor starting components

Objectives:

Examine basic electrical theory  
 Explain series circuit characteristics  
 Explain parallel circuit characteristics  
 Calculate electrical circuit values

- Analyze series/parallel circuits
- Describe electrical meter operation
- Measure electrical circuit values
- Identify electrical symbols
- Draw basic HVAC electrical circuit diagrams
- Interpret basic HVAC schematic diagrams
- Interpret advanced HVAC schematic diagrams
- Explain AC circuit characteristics
- Describe power distribution transformer systems
- Calculate HVAC branch circuit conductor, breaker and disconnect sizes
- Examine basic motor theory
- Draw single phase motor diagrams
- Explain single-phase motor starting relay operation
- Calculate motor capacitor replacement values
- Explain three-phase motor operation
- Explain ECM motor operation

- Indoor air quality – Module 4

Minimum hours: 15, CWI hours: 15

- Pollutants and pollutant pathways
- Prevention, control and remediation strategy
- Tools and testing
- Energy recovery ventilation systems\*
- Filters and humidifiers\*
- IAQ checklists
- Home energy/IAQ evaluation\*

Objectives:

- Describe indoor air quality factors as related to HVAC
- Identify various indoor air quality pollutant and pollutant pathways
- Describe indoor air quality evaluation and measurement tools
- Explain appropriate prevention, control and resolution strategies for IAQ issues
- Determine guidelines for involving professionals in IAQ issues

- Residential load calculation – Module 5

Minimum hours: 21, CWI hours: 33 hours

- Calculations to determine residential heat gain / loss\*

Objectives:

- Examine importance of heat load calculation in building design
- Differentiate sensible, latent and total heat gain/loss
- Determine U values and R values for various building construction components
- Calculate Btu gain/loss values using HTM and temperature difference factors
- Determine heating and cooling load temperature difference and daily range values
- Explain the relationship between house orientation and solar heat gain
- Perform building component area and volume calculations from blueprints
- Perform winter/summer infiltration calculations using Manual J procedures
- Perform heat gain calculations using Manual J procedures
- Perform heat loss calculations using Manual J procedures
- Determine sensible, latent and total heat house block and room values

## HVAC Year Three

Total Hours: Minimum = **144**  
CWI = **168**

▪ Basic controls – Module 1

Minimum: 30 hours, CWI: 39 hours

- Basic electro-mechanical control devices
- Gas, oil, electric and hydronic heating controls
- Manufacturer wiring diagram analysis
- Troubleshooting electric control devices
- Residential air conditioning control systems
- Commercial and industrial air conditioning control systems
- Electronic control devices
- Electronic control module troubleshooting procedures

Objectives:

Explain contactor, relay and overload operation  
Explain thermostat, pressure switch and transformer operation  
Describe standing pilot gas burner control systems  
Describe intermittent and direct ignition gas burner control systems  
Examine gas furnace manufacturer wiring diagrams  
Explain oil furnace primary control operation  
Describe electric furnace operating sequence  
Describe hydronic heating system controls  
Perform gas, oil and electric heating control system troubleshooting procedures  
Describe motor circuit troubleshooting procedures  
Examine packaged and split air conditioning systems wiring diagrams  
Identify commercial and industrial air conditioning system control methods  
Describe basic electronic control system troubleshooting procedures

▪ System air flow and duct sizing – Module 2

Minimum: 30 hours, CWI: 30 hours

- Basic principles of air flow
- Air distribution system components
- Air distribution system application and configuration
- Air flow calculation
- Primary equipment selection using Manual J and Manual S\*
- Secondary equipment selection using manufacturer tables
- Basic duct system layout from floor plans
- Duct system sizing using Manual D\*

Objectives:

Describe basic air flow characteristics  
Explain duct system pressures  
Calculate duct system air flow  
Determine proper air flow requirements  
Describe air distribution system configurations  
Select primary heating/cooling equipment using Manual J and Manual S data  
Determine air-side component pressure drops from manufacturer tables  
Sketch a residential duct system layout using a home floor plan and Manual D tables  
Complete Manual D effective length, friction rate and duct sizing worksheets  
Perform Manual D duct sizing exercises

▪ Basic air conditioning and refrigeration – Module 3

Minimum: 30 hours, CWI: 39 hours

- Thermodynamics and heat transfer principals
- Refrigeration cycle operating principals
- Pressure / temperature relationship
- Refrigeration system components and operation
- Refrigerant properties and characteristics

- Refrigerant oils – types and application
- Refrigeration system access tools and procedures
- Refrigerant management- EPA Section 608\*
- Refrigeration system recovery, evacuation and charging procedures

Objectives:

Explain latent, sensible and total heat differences  
 Diagram refrigeration cycle conditions and components  
 Explain pressure-enthalpy diagrams  
 Examine compressor design and efficiency  
 Explain water/air-cooled condenser operation and performance  
 Examine metering device design and operation  
 Describe evaporator types  
 Identify proper refrigerant line sizing and installation practices  
 Explain various refrigerant physical and chemical properties  
 Explain refrigerant oil properties and application  
 Describe proper refrigeration system access procedures  
 Differentiate between recovered, recycled and reclaimed refrigerant  
 Explain proper refrigerant recovery, evacuation and charging procedures

▪ Introduction to Hydronics – Module 4

Minimum: 6 hours, CWI: 12 hours

- Operating principles
- Piping systems
- Preventative maintenance
- Components
- System overview

Objectives:

Identify hydronic piping system types  
 Describe hydronic heating system components  
 Explain hydronic heating systems drain and fill procedures  
 Diagram basic hydronic heating system control circuits

▪ Basic sheet metal – Module 5

- Minimum: 39 hours, CWI: 33 hours (If performing actual sheet metal layout & fabrication in a shop setting, it will take 39 hours to complete these objectives. If using construction paper to layout and fabricate in a classroom setting, less time is required to complete the objectives.)

- Sheet metal layout and processes
- Parallel line development and fabrication
- Radial line development and fabrication
- Triangulation development and fabrication
- Layout and fabricate various duct fittings

Objectives:

Define basic sheet metal layout terms  
 Explain three methods of sheet metal layout development  
 Explain parallel line development procedures  
 Layout and fabricate the following sheet metal fittings: Pittsburgh seam and square elbow  
 Layout and fabricate the following sheet metal fitting: 90 degree elbow and transition  
 Explain radial line development procedures  
 Layout and fabricate the following sheet metal fitting: symmetrical tapered duct  
 Layout and fabricate the following sheet metal fitting: square to square tapered duct  
 Explain triangulation development procedures  
 Layout and fabricate the following sheet metal fitting: two-way offset transition  
 Layout and fabricate the following sheet metal fitting: tapered duct section

▪ Introduction to service – Module 6

Minimum: 9 hours, CWI: 15 hours

- Air conditioning mechanical, electrical and refrigeration system analysis
- Gas heating system mechanical, electrical and combustion analysis
- Oil heating system mechanical, electrical and combustion analysis
- Electric heating system mechanical and electrical analysis
- Heating and cooling equipment maintenance procedures\*

Objectives:

Describe air conditioning system problems and prescribe corrections

Describe gas heating system problems and prescribe corrections

Describe oil heating system problems and prescribe corrections

Describe electric heating system problems and prescribe corrections

List gas, oil and electric heating and air conditioning maintenance procedures

## **HVAC Year Four**

Total Hours: Minimum = **144**

CWI = **162**

▪ Introduction to Testing and Balancing – Module 1

Minimum: 12 hours, CWI: 12 hours

- Psychrometrics – Fundamentals of the Properties of Air
- Psychrometrics – Calculating the Performance of HVAC Equipment
- Testing and Balancing Tools\*
- Basic Air & Water Testing and Balancing Procedures\*

Objectives:

Explain psychrometric properties

Diagram psychrometric conditions

Describe air flow and water flow measuring devices

Explain basic air flow and water flow balancing procedures

▪ Introduction to HVAC Control Strategies – Module 2

Minimum: 6 hours, CWI: 6 hours

- HVAC Systems & Control Basics
- Electric Control Systems
- Pneumatic & DDC Control Systems

Objectives:

Describe basic HVAC control principals

Interpret basic HVAC pneumatic control diagrams

Explain DDC control system basic operation

▪ Advanced Air Conditioning and Heat Pump Systems – Module 3

Minimum: 39 hours, CWI: 42 hours

- Commercial Air Conditioning Systems
- Packaged Unit Air Handling Systems
- Water Chillers
- Cooling Towers
- Basic Heat Pump Theory
- Heat Pump Components
- Heat Pump Charging Procedures
- Heat Pump Electrical Systems
- Heat Pump Defrost Systems



- Heat Pump Service Procedures
- Heat Pump Troubleshooting Procedures
- Water Source Heat Pump Design\*
- Water Source Heat Pump Components
- Water Source Heat Pump Troubleshooting Procedures

Objectives:

Explain commercial fan coil unit operation  
 Examine package unit building system configurations  
 Describe building chilled water system operation  
 Describe induced and forced draft cooling tower operation  
 Explain heat pump heating and cooling cycles  
 Describe the purpose and operation of various heat pump components  
 Prescribe heat pump charging procedures  
 Examine heat pump manufacturer electrical wiring diagrams  
 Differentiate heat pump time/temperature and demand defrost control systems  
 Explain heat pump service checklist readings  
 Interpret air source heat pump diagnostics  
 Explain geothermal heat pump system applications  
 Describe water-to-air and water-to-water heat pump operation  
 Interpret water source heat pump diagnostics

▪ Advanced Service – Module 4

Minimum: 24 hours, CWI: 39 hours

- Air Conditioning Air Side Troubleshooting Procedures
- Air Conditioning Refrigeration Side Troubleshooting Procedures
- Air Conditioning Service Diagnostics
- Air Conditioning Electrical Schematics & Troubleshooting Procedures
- Gas Furnace Electrical Schematics & Troubleshooting Procedures
- Gas Furnace Service Diagnostics
- Electric Furnace Service Diagnostics
- Oil Furnace Service Diagnostics

Objectives:

Prescribe air flow troubleshooting procedures  
 Explain standard and high efficiency air conditioner operation  
 Explain service checklist readings  
 Determine variable load air conditioning operating conditions  
 Prescribe refrigeration side troubleshooting procedures  
 Troubleshoot residential and commercial control systems  
 Interpret air conditioning manufacturer electrical wiring diagrams  
 Perform interactive air conditioning technician service calls  
 Prescribe gas furnace troubleshooting procedures  
 Perform interactive gas furnace technician service calls  
 Prescribe electric furnace troubleshooting procedures  
 Prescribe oil furnace troubleshooting procedures

▪ System Integration and Design (Project format) – Module 5

Minimum: 12 hours, CWI: 12 hours

- Residential Comfort and Design Standards\*
- Primary Equipment Selection and Sizing\*
- Primary Equipment Installation and Operation\*
- System Replacement and Retrofit\*

Objectives:

Describe residential comfort and design standards

Examine residential equipment selection and sizing requirements  
List residential equipment installation and startup procedures  
Prescribe residential equipment retrofit procedures

#### Code review – Module 6

Minimum: 42 hours, CWI: 42 hours

- Review of International Fuel Gas Code (27 hrs)
- Review of International Mechanical Code\* (9 hrs)
- Review of National Electrical Code (6 hrs)

#### Objectives:

Identify International Code administrative and enforcement rules  
Describe the building structural safety requirements for fuel gas equipment installation  
Examine fuel gas equipment combustion, ventilation and dilution air requirements  
Identify fuel gas equipment location, access and service space requirements  
Perform gas pipe sizing exercises  
Identify proper gas pipe installation methods  
Examine chimney and gas vent installation requirements  
Perform single and multiple category I vent sizing exercises  
Examine specific fuel gas appliance installation requirements  
Describe mechanical equipment location, access and service space requirements  
Identify proper supply, return and exhaust air system installation methods  
Examine specific mechanical equipment installation requirements  
Identify proper HVAC equipment branch circuit installation methods  
Perform HVAC equipment branch circuit sizing exercises

#### ■ Project Management – Module 7

Minimum: 9 hours, CWI: 9 hours

- Personnel Management
- Communication Skills
- Project Control
- Inter-Trade Relations
- Work Ethics

#### Objectives:

Perform problem solving and decision making exercises  
Perform active communication exercises  
Describe proper project control methods

\* Denotes curriculum areas that cover energy efficiency, environmental impact and green construction.

Performance objectives are divided into 3 hour blocks of classroom instruction unless otherwise noted.